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Bolesław Czarnecki and Tadeusz Czarnecki

Is Augmented Reality a Source of New Types of Knowledge?

Abstract: Some everyday cases of cognition show how computers functioning within Plain Reality give us a new type of knowledge. In contrast, the project of Augmented Reality is epistemologically challenging because it proposes hybrid scenarios which are friendly for cognitive agencies but infuse them with Virtual Reality (VR) overlay that is alienated from reality. Working with the assumption that Augmented Reality is ontologically heterogeneous, as it mixes experiences of individual objects with experiences of models, we examine its cognitive usefulness. We argue that insofar as our cognitive contact with Augmented Reality-based simulations may be even better than the celebrated contact with reality, there is room for extending the notion of knowledge.

Keywords: knowledge-that, knowledge-how, skill, Augmented Reality, model, simulation, registration, instrumental value.

1. Introduction

Pieces of knowledge-*that* may be interpreted as products of cognitive agents who, for example, transform their veridical experiences into true beliefs. Skeptical “Brain in a Vat” (BIV) scenario suggests that a brain totally immersed into Virtual Reality (VR) stands no chance of coming to know because its agency and experiences become illusory. We question whether BIV scenario is consistent if it does not explain how the agency of a brain can be reconstructed on the basis of VR experiences. Granting that agency and “contact with reality” are standard conditions for knowledge-*that* to emerge, we ask what is required to create an environment for a new type of experience which could result in a new type of knowledge. Such an environment should not violate cognitive agency and offer a new type of non-deceptive experience. There are everyday cases of cognition which show how computers functioning within Plain Reality provide us with information which is a new type of knowledge. These cases are easily acceptable because the information respects the requirement that we remain in touch with reality. In contrast, the project of Augmented Reality is epistemologically challenging because it proposes hybrid scenarios which are friendly for cognitive agencies but infuse them with VR overlay that is alienated from reality. Augmented Reality scenarios do not tamper with our senses and essentially extend of our

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experiences. They provoke, however, the question in what sense VR overlay could be veridical, as it somehow must be in order to support instances of new types of knowledge. We propose that it is helpful to assume that Augmented Reality is ontologically heterogeneous and mixes experiences of individual objects with experiences of models. Models become cognitively useful when they are models of future individuals, and are adequately anchored in reality. If this last condition is satisfied, cognitively advantageous situations may be generated whereby we experience 3D models in the environment of individuals, rather than 2D models in the environment of other 2D models. In this paper, we mainly consider the usefulness of 3D presentations in quite a different context of possible extensions of knowledge-*how*. That is, we analyze the possibility that 3D artificial experiences of an agent are sufficiently multilayered to generate their new manual skills. Though skeptical about it, we try to formulate conditions which augmented experiences should fulfil to generate reliable simulations of new manual skills. We claim that in both areas of knowledge simulation is the crucial component to take into account. We believe that our cognitive contact with simulations may be even better than the celebrated contact with reality. Especially, if simulations are able to diminish the risk of failure when we strive for useful information or useful manual skill in order to obtain practical goals. If we adhere to the idea that problems should precede pieces of knowledge necessary to solve them, then reliable simulations may be indisputably more valuable in solving problems than fully veridical experience. Thus, we finally come to a conclusion that Augmented Reality project gives us perhaps a strategic impulse to extend the basic notion of knowledge and ask on what conditions new types of knowledge can be found in the sphere of computer simulations.

2. Skeptical VR scenario

Epistemologists resign themselves to the idea that cognitive agents fully immersed in Virtual Reality (VR) cannot have knowledge, perceptual knowledge, in particular. Let's try to explain first who are cognitive agents. Minimally, they are meant to be individuals of sufficient cognitive abilities and skills to acquire and sustain their own justified true beliefs. To be an agent requires having cognitive autonomy. A criterion of cognitive autonomy is self-knowledge: an agent has to know who they cognitively are. They need to be cognitively sensitive to their cognitive self. And this seems to involve the agent's knowing what their cognitive skills and capacities are. Another, and more obvious criterion is that to be an agent one has to have successful cognitive grasp of reality: an agent has to know to a degree what reality is like and this knowledge should be acquired

in virtue of their own skills and capacities. In any case, reliable evaluation of one's cognitive resources is a necessary condition on having knowledge about reality.¹

The question whether computer simulations could extend one's knowledge may have an affirmative answer if we assume that such simulations (1) do not violate someone's cognitive agency and (2) information that they provide for the agent remains in a way reliably veridical: it systematically maps the reality, or, at least, it is not systematically cognitively deceptive. Here, however, we face a deeper question whether simulations can give us new knowledge. It seems that Virtual Reality opens the possibility of immediate artificial experience which precedes or even predicts future facts and may be in a special sense veridical. Still, the agent must intellectually process the experience to produce cognitively useful beliefs. The intellectual operation of predicting future, which requires special cognitive skills of reasoning, would then change into direct seeing of future facts.

We can easily imagine that the agent is provided with reality-like 3D experience of a new type which was impossible to acquire without computer processing. It surely opens a window of opportunity for new type of knowledge. Now, we want once again to stress the difference between feeding an agent with experiences and formulating by the agents their own beliefs on the basis of these experiences. We will claim that artificial experiences need not to be deceptive if the agent consistently distinguishes between objects of reality and models of reality. Along with that, we assume that ascriptions of cognitive success to someone are fully justified only on the level of their beliefs, not on the level of experiences. For simplicity, we envisage perceptual experiences here as connected with natural capacities had by an agent, i.e., the senses, whereas the agent's perceptual beliefs are connected with something well beyond: skills of interpretation acquired by cognitive training. Agents typically learn how to formulate perceptual beliefs and the strength of their agency is measured by their skills of interpretation.

Epistemologists seem equally fascinated with virtuous and vicious cognitive scenarios involving computer processed information. A "Brain in a Vat" (BIV)

¹ These remarks locate our proposal within a vast range of virtue-theoretic approaches, particularly those of Montmarquet (1987), Sosa (1980, 2007, 2015) and Zagzebski (1996), where the multilayered notion of skillful cognitive engagement is central. That said, we will largely remain neutral with respect to other proposals on offer. Where our proposal stands out most clearly, perhaps, is in respect of value-turn aspect of cognitive virtue (see Pritchard 2007).

scenario is of the latter kind.² Typical variants of BIV are intended to offer situations of full cognitive deception. An important deficiency of these scenarios, however, is that they contain explanatory gaps that prevent us from understanding what implies full cognitive deception. In effect, we face the question of what it would take for a BIV scenario to constitute a credible BIVR scenario – “Brain in Virtual Reality.”³ As far as standard BIVs are concerned, epistemologists stress (1) the cognitive isolation of the discarnate brain, (2) cognitive cruelty of the mad scientist who manipulates the brain and (3) the unlimited creative capabilities of the computer he uses to feed the brain with artificial experiences. It is then declared that whatever the brain is cognitively fed with depends entirely of the mad scientist who controls the computer which is the only source of the brain’s experiences.

But consider, very briefly, problems with two variants of BIV: *envatment of cognitive agency*, which is an instance of full deception, and *doxastic envatment*, whereby beliefs are under threat, even though cognitive agency has not been compromised.⁴

We think that full deception is not an easy task to achieve if one assumes that the brain should be deceived only on the level of its beliefs: the brain would be fully deceived if it acquired false beliefs at the manipulator’s will. However, for it to acquire any belief, the brain must retain cognitive agency, which involves the capacity for self-evaluation of its abilities and skills. This requirement may cause unpleasant restrictions on the manipulator’s alleged omnipotence. After all, how does it happen that the discarnate brain remains convinced of his intact cognitive agency? How is it made the case that although in no way the brain controls its cognitive processes it is still convinced that it does? Even if the manipulator materially faces a brain, he must cognitively challenge an agent. Here, we think, the manipulator has two options to choose from, and both equally mysterious. Firstly, he may try to reconstruct the original cognitive agency of the brain. How could he know how to do this? How could he have a full access to the original cognitive agency of the brain? Secondly, he could wash the brain and overlay on it a new cognitive agency. Again, what would that mean? Either option leads to the following problem: How is it possible to deceive the brain

² For the classical formulation see Putnam (2000). For distinct interpretations and treatments see Brueckner (1986) and Warfield (1995). For the most recent assessment of skeptical strategies including BIV, see Pritchard (2016) and Wright (1992).

³ Dennett (1993) outlines a number of concerns in a similar spirit.

⁴ In a related context of cognitive extension Pritchard (2010) maintains that in the BIV scenario an agent could easily be fed *beliefs* of various types. We contend that *doxastic envatment* is not an easy epistemic situation to achieve.

about its cognitive agency without recreating its cognitive autonomy? We think it is exceptionally difficult to state what processes the recreation should involve to be successful. In effect, we suspect that epistemologists do not quite know what they talk about when they consider cognitive implications of “Brain in a Vat” scenarios.

The *doxastic envatment* variant of the scenario seems a bit simpler. It concerns causal chains resulting in the brain’s artificial experiences. Specifically, causal chains resulting in perceptual experience of the brain are always mediated by the computer. For instance, they may begin within the computer and then lead to deceptive experience, or begin within the reality, but then get transformed by the computer in ways that make experience unreliable. Crucially, and this presumably is the most speculative component of the story, deception coming from the scientist *via* the computer mainly consists in their switching at will between falsidical and veridical perceptual experiences to provoke the brain – made to believe to some extent that it is a cognitive agent – to formulate false beliefs about the reality. Whether beliefs turn out true or false does not matter much, since falsidical experience that underpins them is *ex hypothesi* totally worthless, whereas veridical experience is unreliable and, therefore, hardly better. Here again, however, one faces the question: How to engineer a virtual environment (like a real one!) that supports the generation or maintenance of false beliefs about reality without the brain – which is to a significant degree cognitively autonomous – ever forming a belief that its experience is deceptive?

There are no proposals to explain why the brain believes that it is an agent having typical cognitive abilities and special cognitive character; how the manipulator makes the brain think that it has a living body which is perceptually sensitive and skillful in acting, has its own cognitive aims, own practical targets, and so on.

It is not our aim, however, to engage with BIV scenarios in detail, but merely to highlight that they purport to show, one-sidedly, that Virtual Reality is cognitively useless without explaining why. Usually they are imprecise as to whether and how the brain retains its cognitive agency, how it is possible to produce for it a false cognitive agency, how the false cognitive agency is to be fed with experience to make the brain cognitively satisfied, and so on. What matters for our purposes is that radical scenarios end with the pessimistic conclusion, not necessarily well justified, that no VR information in no VR world for no VR agent can become a form of knowledge.

3. Benign scenarios involving computer information

Normally, we take it for granted when using computers that our cognitive agency is impregnable to a sufficient degree. To be sure, the quality of interaction with computers is becoming increasingly agent-like. Nevertheless, as things stand we give our computers no chance to deceive us as to who we are as cognitive agents, and they are frequently reduced to being our sources of information. Crucially, if we see a computer as an independent external object with some information written on its screen, there is often no problem with ascribing a logical value to the information and to decide whether it is reliable enough to provide for us a source of knowledge-that. Similarly, if we watch 2D pictures displayed on a computer screen which is a separate object within our field of view among other external objects, it is often easy enough to decide whether the computer pictures carry true information, e.g., whether they map the reality around us in epistemically salient ways. Whenever that's the case, the basic epistemic problem is just that: What cognitive use are we able to make of the information?

3.1 Operational knowledge-*that*

Let's distinguish between factive knowledge-*that*, and operational knowledge-*that*. For example, as a skilled car driver Ela believes that GPS truly shows to her both where she is and where she should go. The first information is factive, whereas the second is operational. If GPS reliably transmits true information, there is no problem with ascribing to her knowledge that she is here-and-so and that she should go there-and-so. Both types of knowledge are interconnected: GPS enables Ela to know where she should drive because it also enables her know where she is. Typically, GPS knowledge is of essential instrumental value, i.e., often one wants to know where one is not because they just want to know where they are but because it helps them to move efficiently; and, in Ela's case, to reach some previously established destination point.

If Ela is a skillful interpreter of GPS visualizations, these help her to remain on the right track towards her final destination. Arguably, this type of knowledge is of a new type because she knows where she is and where to go in the surroundings that are totally unfamiliar to her. Factively, she may be lost, but operationally she is still in control. With this kind of operational knowledge she can move efficiently. In contrast, if she only had factive knowledge where she is

and what destination point she wants to reach, this knowledge in unknown surroundings would be useless.

Locally, GPS information may be functionally on a par with information provided by a system of road signs which are all elements of reality. For instance, some signs point Ela in the right direction, so when she sees and follows these, she doesn't need to follow information from GPS. Indeed, GPS has no monopoly on guiding her driving, though usually it guides her more efficiently and, absent technological mishaps, more reliably than road signs. But there are important differences in what the road signs and GPS afford to Ela. First, unlike signs, GPS makes her driving in unknown areas as smooth as her driving in well-known areas. But there is also a robust qualitative difference that goes beyond the degree of efficiency, namely, that GPS opens for Ela a new perspective on moving. Using it, Ela may identify her position and a way to a destination in unknown surroundings: starting in *any* unknown place Ela may move efficiently to *any other* unknown place. She can navigate without first becoming a navigator herself.

Now, we find it vital for our discussion of Augmented Reality to introduce the following enabling condition. When digital information is displayed in such a way that the computer and its screen are invisible to you, and it seems to you that the information is placed immediately in reality which surrounds you, then you find yourself in Augmented Reality. We think an important definitional implication is that when computer-generated information transforms Plain Reality into Augmented Reality, the information enriches your overall experience in a mode that bypasses and, is experientially insulated from, experiences caused by external objects. And if we could precisely define what are the new types of experiences, then we could also define new types of experiential knowledge. As we see it, then, GPS projections on one's mobile phone screen are not yet a part of Augmented Reality, though they easily could be. To satisfy the condition, it is enough to make invisible the screen on which the information is primarily displayed.

Consider the following to be a somewhat more precise elaboration of that condition. So long as a computer screen is a visible external object, and together with other external objects co-creates one's field of view, then what one experiences is treated as part of Plain Reality. Plain Reality transforms into Augmented Reality when one sees information that is displayed on a fully transparent screen which creates new boundaries of one's field of view, but is not itself a part of their field of view. If one has the impression that any pictorial or written information they see is present immediately among external objects, then they face what is called Augmented Reality. Finally, one finds oneself within Mixed Reality, if when equipped with a device containing a transparent screen, they can ex-

perience 3D objects which seem to be placed in the fragment of reality that they actually see through the screen. The simplest way of making GPS a part of Augmented Reality is by generating a visible secondary screen within an invisible primary screen. These are basic tricks of Mixed Reality: to generate 3D artificial experience by displaying information on a transparent screen or by displaying new 2D visible secondary screens behind the invisible primary screen.

There are two systematic illusions connected with creating an Augmented Reality. Firstly, even if a screen is necessary to generate projections, it must be so positioned as if there were no screen at all, that is, as if you had an unmediated visual contact only with external objects and *via* unaided eye. Secondly, all 3D projections are illusory in the following sense: Reality remains unchanged, only our artificial experiences change. A question to answer is what can be the cognitive status of 3D projections. If they are virtual, how could they be sources of knowledge-*that*?

3.2 Knowledge-*how* to act

Computer information may be decisive in acquiring knowledge-*how* to act. In particular, simulators when coupled with computer simulations seem highly effective in supporting the acquisition of manual knowledge-*how* to act. For instance, we can significantly deepen our skills of driving a car. Technically, standard simulators involve real tools, such as a driving wheel to manipulate, along with computer simulations projected on a computer screen which visualize predicted results of our manipulations. What is important here is that standard simulation procedures combine real causes, real actions, and predicted unreal results, with our bodies being engaged in manipulating material tools essentially similar to those we will use in performing real actions. For example, we manipulate a wheel which functionally resembles a real driving wheel with the expected final result being a real skill acquired by simulated training. Standard simulators are valuable because they enable us to learn through “trial and error” with no negative results characteristic of real errors: when we make simulated errors no real damage is done. We can learn on errors which have only virtual consequences.

In a special sense, such knowledge-*how* is of a new type because virtual errors are pedagogically as efficient as real errors. At this juncture, an important question arises whether we can go any further in learning by computer simulations and apply Augmented Reality to acquire real manual skills either *via* (1) reversing the order of causes and results, i.e., starting with simulated causes and

ending with real effects, or (2) totally breaking the pattern by substituting real causes and effects with simulated caused and effects.

Arguably, when we entirely separate ourselves from reality, we are unable to acquire manual skills. For example, we cannot learn how to drive a car only by making thought experiments, i.e., by imagining that we manipulate a driving wheel in a certain way and imagining that the results we obtain are such and such. An argument supporting this claim would be that these imaginary simulations cannot work because there is no reliable connection between imaginary moving of an imaginary driving wheel and imaginary results of imaginary driving. These imaginary causes and the results are in no way anchored in reality.

Now, a question may be asked whether we can eliminate the drawbacks of thought experiments by simulations made within Mixed Reality. Whether we can learn how to drive a car by applying a virtual wheel of a virtual car in a real scenery or a virtual wheel connected with a virtual secondary screen presenting virtual surroundings. It seems that much would depend on anchoring all the important elements of such augmented simulation in reality. But then still further problems arise. To acquire a manual skill something more is necessary than new visual experiences. We need new bodily experiences such as, for example, new kinaesthetic feelings. Such feelings do not arise without tactile experiences in our body. But it is unclear whether Magic Leap project, for example, has ambitions to equip us with new artificial tactile experiences.⁵

4. Non-standard simulations and new knowledge-how

People alone cannot transform stored information about their past natural experiences into the same experiences again: they cannot re-vitalize past experiences. They also cannot see objects they only have thought about or imagined: they cannot pre-vitalize future experiences. In contrast, information stored in computer's memory can be repeatedly transformed into people's artificial perceptual experience. This opens the doors for experiences transcending time. Similarly, people cannot generate visual simulations of objects, events or actions at will, but computers give them this special possibility.

⁵ Here one may also find it useful to engage more closely with distributed cognition frameworks, particularly those that focus on embodied and enactive character of skill, to then present a case for a new type of tactile cognitive extension through AR.

In some sense standard characterisations of Augmented Reality, following Azuma's (1997) definition which requires that it combine the real and virtual, be interactive in real time and registered in 3D, are somewhat misleading since they may incite the hope that computer technologies are aimed at bringing direct changes in the world. It is obvious that augmentation makes sophisticated hardware appear in the world, but when we speak of the results of augmentation it should be clear that we mean solely changes in our experience caused *by* this hardware. Firstly then, to straighten out the matter of what augmentation may change, it is useful to stress that (1) experience alone does not change the world and (2) the world provides the ultimate point of reference, but in decidedly different ways, both for our natural experiences and artificial experiences generated by computer technologies. Natural experiences are caused by, whereas artificial experiences must be registered with, the world to count for us. The world does not materially change by augmentation though our experience may change immensely, and we augment our experience reasonably when, for example, inspired by instrumental reasoning about means to obtain ends, we decide to make a change in the world and, before we actually make it, thanks to artificial experience we feel well prepared to succeed in making it. We deliberately change the world only by actions, although we may precede the actions with deliberate augmentations.

Thus, the issue of Augmented Reality begins to look serious if we manipulate our experiences motivated by problems we face and our perseverance to solve them. Anyway, here we distinguish between capricious augmentations which are art for its own sake and purposeful augmentations which prepare us to undertake actions to successfully change the world in order to improve our position in it.

From the point of view of epistemology, inspiring are these definitional conditions which require that Augmented Reality be a medium for displaying 3D presentations (1) registered with the world and (2) phenomenally adjusted to the world and the agent who perceives them.⁶ These conditions imply, for example, that if some places are chosen in the world as stable points of reference and an agent using Augmented Reality glasses is a mobile point of reference, then the way he is experiencing virtual objects is fully consistent with the way he is experiencing material objects. Experiences of both types should follow the same rules of presentation, or their basic phenomenology should have the same gram-

⁶ For a characterization of AR as medium rather than a type of technology itself see Craig (2013). For a survey of definitions see Billingham et al. (2015) and Grubert et al. (2016). The latter discuss conditions for *pervasive* Augmented Reality that would offer continuous experience of reality-registered presentations and be context-aware.

mar. That is, if the shape a virtual object is experienced in a particular way by an agent, the shape of its physical counterpart would be experienced by him in the same way.

A desirable property of augmented experiences is their plasticity. Natural visual experiences are not essentially plastic in relation to the agent. To retain veridicality, their content must be determined by external causes, i.e., properties of material objects. Augmented Reality offers the agent an option of controlling the substance of their artificial experiences. And it is fascinating that artificial experience may become interactive in relation to its agents, whereas natural experience is interactive mainly in relation to its objects. The property of plasticity is intellectually promising when manipulations are meant to display, for example, a sequence of possible states of affairs to allow us to make the best choice between them.

A separate question is whether the plasticity of experience is practically promising, i.e., whether by manipulating artificial experiences we can improve our manual skills; whether, in particular, we can acquire new manual skills by manipulating our experiences of manipulating virtual objects, instead of manipulating material objects. It is important whether Augmented Reality technologies can simulate causal connections between, for example, artificial experiences of an agent and bodily skills of the agent. Standard simulators destined for teaching manual skills connect authentic bodily actions engaging physical tools with computer simulations of their results in some virtual surroundings. That is, such simulations predict only the results of actually performed actions: real causes are combined with reliably predicted though unreal effects.

Could we introduce non-standard simulators which would reverse the order of real causes and simulated effects while retaining the reliability of standard simulators (i.e. ones where we begin with virtual causes and reliably end with real effects)? Think, for instance, of a golf stroke simulator that mixes strokes performed with real clubs and balls *with* virtual trajectories of the balls visualized on a screen. Can it allow for the possibility of augmented *strokes*? The person in such a scenario sees their body performing moves characteristic of a stroke, but the stroke is partially augmented as it involves artificial experience of a club. They strike the ball by engaging their real body, in the real surroundings of a golf course, yet its result is artificially visualized in the real space of the course. Could we make such reverse simulations reliable? If we could, we could also improve our game by such simulations. This would mean that we have an unquestionably new source of knowledge-*how* to act.

Thus, we face many questions concerning the possibility of extension both of the methodology of learning how to act and, further, the environment of acting; the possibility that our actions easily switch between Plain Reality and Augment-

ed Reality. The fundamental one is whether it is practically illuminating to mix manual moves of a body with virtual tools and observe their virtual results in the real world. We show below how one could learn intellectually by mixing two worlds of objects, but the question remains whether one can also learn manually by mixing two worlds of actions. Especially, when the learning begins with highly augmented bodily moves and but its aim are real results of the moves.

It seems uncontroversial that augmentation may develop the intellectual aspect of manual actions because spatio-temporal manipulations may turn out sufficiently helpful to decide whether or not one encounters an opportunity to act. We can plan virtually how to make the best use of the skills we already possess. But it is uncertain whether augmentation gives us a chance to improve the skills themselves, or whether it always makes sense to try to improve them by augmentation.

Let's take a closer look at the golf shot case. When one has artificial experience of a golf club, then its location is independent of where one is and how they move. One clearly is the viewer of the virtual club. But can they also be the user of the virtual club? If one's artificial experience of a club were mixed with their natural experience of a golf course, then the experience of the club would be rooted in a hardware, whereas the experience of the golf course would be rooted in reality. There would, then, be two independent causal chains of their intertwined experience, one that hinges on the external world and the other that is enabled by computer stored information. Generally, where virtual objects are involved, these exist imprisoned in a computer, as opposed to the physical world. Optimists about artificial experience may try to persuade us that due to its spatio-temporal registration with the world, the club may be felt present in the world.⁷ But spatio-temporal location is only the tip of the iceberg when we try to understand what would be the profile of artificial experience such as to make one feel, and believe, that they are actually producing a golf shot with a virtual club and ball. Minimally, a reliable simulation seems required of one's bodily contact with the ball *via* the club, a reliable simulation of the physical impact of the club on the ball and, finally, a reliable simulation of the result of the impact. If this can be done, Augmented Reality will become a powerful source of knowledge-how. But can this be done? And, further, does it always make sense to produce non-standard simulations?

Apart from its location in the world, a physical club also has dispositional properties that determine its identity as a specific tool. It is in virtue of these properties that the club responds in certain ways to certain bodily actions of

⁷ See Craig (2013).

the player and can be used purposefully. If we are not mistaken, Augmented Reality technologies at their present stage of development enable one to change the location of a virtual club, however, it is dubious whether they also enable them to use it.

Clearly, one cannot directly strike a physical ball with a virtual club, i.e., with their artificial experience of a club. And this is because there are no direct causal links between one's body, their experiences of virtual objects such as a club, and the target physical object – in our case, the ball. Now, direct causal links would be dispensable if they could be reliably simulated. Could the causal links between one's body and a physical object, which standardly create an action, be reliably simulated when, with their body, one intends to make some use of that object's virtual counterpart? This troublesome question demands a precise answer. And as long as we don't know what types of dispositional properties of virtual objects could be reliably simulated, we also don't know what actions engaging these objects could be simulated.

At present, real objects and virtual objects have very distant grammars of dispositional properties. That is, our interactions with virtual objects are so far one-sided and primitive in comparison with interactions we can have with physical objects in Plain Reality. And it is hard to predict whether this distance will be essentially shortened and which dispositional properties will be selected as worth simulating. Anyway, as we need in advance a list of dispositional properties of physical objects if we want to evaluate their manual utility, similarly, we will need to have a list of respective simulations if we want to act in Mixed Reality effectively and reasonably.

There are, therefore, two limitations to break if we are to acquire new knowledge-*how* while being immersed in Mixed Reality. First limitation pertains to the physical impact that one's body can be simulated to have on virtual objects. The second one concerns the impact that virtual objects can be simulated to have on the physical world, including one's body. So far, it is unclear whether the breaking has been started. Though spatio-temporal registration with the world is undoubtedly a success, something we could call "dispositional registration" would surely outbalance its significance. It would be quite stimulating if we could manipulate dispositional properties of virtual objects, eliminating the undesirable and adding or enhancing the desirable ones. But, again, we don't know when such augmentations will be possible, and so it is difficult to say, for example, which types of simulations we should avoid or accept.

5. Chances of new types of knowledge-*that*

It is said that some 3D virtual objects may have their physical counterparts. This claim is somewhat disputable. If one entertains 3D artificial experience of a golf club which is modelled on a particular club that one actually has, is their real club a counterpart of the virtual club? Is the virtual club one sees an individual? Generally, are 3D virtual objects one sees *via* Augmented Reality headsets individuals? There are reasons to hold they are not.

Firstly, the objects of artificial experience function as, and have properties of, models, i.e., general objects. They are the same for all users of a headset. i.e., the same digital information is processed to produce the same artificial experiences for many people. When they are displayed, all users of headsets of a type enjoy qualitatively the same possibilities of experiences. Objects displayed in Mixed Reality presentations provide, of course, various sorts of models: (1) Models of objects which exist, (2) models of non-existing objects which are intended to exist and, finally, models of the unreal objects which are not intended to exist. And if we were to bet which of them are the right candidates for vehicles of new types of knowledge-*that*, our choice would be that models of intended objects.

By models we mean objects that are neither autonomous nor unique entities: objects that can be perfectly replicated, or repeatedly displayed by many displayers, with no change in their visible properties. Similarly, if models undergo a structural change, the change is determined or initiated externally: they are not sources of their own structural changes and, especially, they do not autonomously evolve. A crucial property of 3D models is that they cannot be changed by direct external impact coming from real objects or agents; especially, from direct impact initiated by bodily actions of human agents.

What more can we get to know from Mixed Reality that we cannot get to know from Plain Reality alone? If we ask this question there is a preliminary demarcation line to draw between projections made for mere entertainment, or for purely mercantile purposes, and those made for serious cognitive purposes.⁸ To the extent that computer games are usually made to entertain the consumer, and for financial gain of the seller, we will largely set aside the possibilities of their development. Of course some games escape this qualification, especially when they directly serve educational purposes. In any case, we expect that if serious

⁸ For a roughly similar point on models see Hofmann (2013) who holds that a distinguishing feature of “serious” simulations is their validity, where basic assumptions about what exists, how to come to know, and how to achieve a goal are key determining factors at play.

augmentations of reality entail essential ontological extensions of reality, they should bring original additions to people's bodies of knowledge. If we look through advertisements of Microsoft or Magic Leap technologies, it is often unclear whether they entail such extensions or in what sense they do.⁹

5.1 Seeing models in real surroundings

Mixed Reality (MR) presentations seem sometimes cognitively idle in that they are aimed to make a momentary impression: their programmed result is "Wow!" of the viewer; an exclamation of astonishment. Advertisements of MR equipment offer a lot of cognitively undetermined simulations. That is, when we watch them it is difficult to decide whether they carry any clear message for the viewer as to how to consume them intellectually or practically. As if the ambition of these technologies was restricted only to whether artificial experiences already are, or are not yet, qualitatively indistinguishable from natural experiences; as if nothing more should be required of them beyond the mere capacity to "fool our senses". Fortunately, MR leaders unanimously declare their technologies are intended not to fool us as cognitive agents but, on the contrary, to help us cognitively. How can they help?

One promising development consists in changing the way of designing new objects which are intended to exist. Where the geometry of an object is essential for its future functioning – no matter of what type the object is to be – making spatial models of such objects is indispensable before producing real individuals. The old-fashioned method of designing the geometry of a model consisted in drawing on paper three 2D projections of its intended shape. After which a key turning point came: movable 3D computer projections on a visible computer screen. With recent advancements the question has become: what can we gain when we complete our designs with 3D augmentations, i.e., when we experience a 3D final model of an object in some real surroundings? The answer is that the closer to the reality the model is, the better we know whether the real object will fit the reality. Obviously, we get "perfect" knowledge about fitting only when we see how a real object fits real surroundings. But the second best option is to see a 3D model in real surroundings. Designers acknowledge that the environment of an object is important. For example, architects aim to anticipate whether a house will fit certain real surroundings geometrically and aesthetically; and it is not uncommon that the view of the real object in its real surroundings does not satisfy

⁹ For an informative discussion of the enigmatic Magic Leap see Kelly (2016).

the expectations of its designer; particularly, the real object sometimes looks worse in real surroundings than its model looked in fully artificial surroundings. Although the profit of MR designing is sometimes minor – as when the model shows the shape but cannot show the functioning of the future object – we undoubtedly gain a new type of knowledge when what we see now is as close to the future as possible.

Importantly, the value of such knowledge *that* increases if the object and its surroundings form a whole. If in planning a new type of object we must also plan its physical and functional contexts of functioning, and when its functioning tightly depends on other objects' functioning, then it makes a qualitative epistemic difference that we oppose 3D projections and real objects. A reason is that reality is coarse-grained, whereas models are ideal, or finely-grained. It is an unpleasant shock when it turns out that a model embedded in another model fitted perfectly but a real object embedded in real surroundings does not. Typically, old-fashioned designs consisted of models within models: of models of objects embedded in models of their surroundings. From that angle, transition to the model-reality pair is surely advantageous as it makes designing more reliable and more flexible. We may choose what to put into what. Sometimes it is preferable to put a real object into artificial surroundings, sometimes it is preferable to put an artificial object into real surroundings.

5.2 Seeing the inner structure

An identification mark of the old-fashioned designing were 2D cross-sections of models. As 2D projections showed usually the exterior planes of an object, always when it was also necessary to reveal key connections of its interior elements, 2D cross-sections were unbeatable. They were necessary to show that the design was internally consistent, that there were no conflicts between its elements. As a house, for example, includes different installations, wiring, ventilation, gas fittings, among others, and they must be skillfully coordinated, cross-sections were necessary to show that they were. Now, 3D models offer the possibility of seeing the full interior of a designed object in any scale. We can at will see the interior of a future house in its full scale, along with every element in its real dimensions. It is, therefore, tempting to claim that we can perceive now a future house, or even that we now visually know the house although it does not yet exist. Of course, there is a difference between seeing a model and seeing a real house. A lot may happen between having a finished model and having a target real object. But sometimes we are certain that the difference will be negligible. Although the model and object may eventually differ, this will not be

because the design was internally defective. And this is, we think, the main criterion of having knowledge-*that*: that one is in possession of information which essentially diminishes the risk of their intellectual or practical failure.

We fail practically, for example, when we cannot predict that an object is mechanically unsound, i.e., is not ready to fulfil its standard function. Hence we must not avoid the question whether experimenting with the geometry of an object is essentially helpful for predicting future mechanics of the object. Does artificial experience help to predict whether, for example, a geometrically sound model is also mechanically sound? It may to a degree, if we know in advance the material properties of its elements and we do not need to experiment with their mechanical adequacy. Nevertheless, evaluating the mechanical soundness of a future object is far more complicated than evaluating its geometrical soundness. At that point, we inevitably return to the question about seeing the future which from the beginning was of special significance: Can MR projections show us also the future mechanics of the designed object, show its future inner mechanism at work, especially, if its work is to be dynamic, involving not only moves of many elements but also their functional interaction. If testing a mechanism is necessary, modeling usually becomes an insufficient endeavor because sooner or later we need something more than a model, namely, a prototype of the designed object. In this way, we come to the question whether MR technologies may equip us with models having characteristics of prototypes, with models, for example, enabling us to test the future work of an intended object; to help us to decide that the model is mechanically sound. It would surely be an epistemic breakthrough if we could now know how an object will work because we can see now a reliable MR simulation of its moves. But we doubt that seeing moves of a model makes us know the future work of a real object. If we know in advance how a real object works, MR presentations may be so designed as to show us how it works. But if we don't know in advance how an object works, MR modeling of its moves will not reliably predict its workings. Thus we need to sharply distinguish between virtual presentations of the mechanics of known objects and virtual tests of the mechanics of newly designed objects. Virtual presentations may be pedagogically useful, but are useless when we need reliable tests to acquire knowledge of a new type. We are uncertain whether MR technologies aim at all at producing simulations of reliable prototypes or reliable testing. But as long as they don't, their presentations are mechanically idle in the sense that although they explain a lot of what we already know, they predict very little. If they don't let us test an unreal object functionally, no new window of epistemic opportunity opens.

5.3 The instrumental value of knowledge

It is hard to decide whether MR experiences are sources of new knowledge until one establishes what to expect from our beliefs. Our view is that beliefs, and perceptual beliefs in particular, provide tools which should be utilized, intellectually or practically. And although we accept the distinction between (1) autotelic value of knowledge-*that* – consisting mainly in its truthfulness – and its (2) instrumental value, we don't care much about the former. To our mind, beliefs become instrumentally valuable if we efficiently process them intellectually to gain a result: a final belief which brings a solution to an intellectual problem. If beliefs become reliably efficient in the service of solving problems, they can be classified as pieces of knowledge-*that*. As we see it, efficiency in solving problems is an interesting criterion of possessing knowledge: beliefs we have are pieces of knowledge if they at least diminish our failures in achieving goals. For example, we make an intellectual use of factual beliefs when we use them in explanations of past facts, or in making predictions of future facts. If the explanations/predictions work, beliefs that contribute to them become pieces of knowledge-*that*. More importantly, perhaps, we view as knowledge also those beliefs that efficiently support solutions to our practical problems; beliefs that help us to decide whether to act or, which is even more crucial, how to act. Shortly, knowledge is what equips its possessors with information that is necessary for them not only to think rationally but also to act rationally and, we should stress, skillfully.

6. Conclusions: The scope of artificial knowledge

The issue we investigated in this paper – i.e., whether 3D presentations may initiate new types of knowledge – provides us with problem solving information which could be generally labelled “artificial knowledge”. If we are epistemological conservatives who hold fast to the requirement that knowledge must mean “epistemic contact with reality”, then the answer will be negative. Obviously, such conclusion implies that Augmented Reality presentations are not sources of knowledge-*that*. If, however, we switch to instrumentalism, reasons quickly emerge to start speaking about perceptual knowledge-*that* about the future; especially, if artificial experience presents us with models of objects which we have already decided to materialise and the models are (1) sufficiently close to reality and (2) reinforce our positions as agents. It is of course a tricky question whether, for example, one sees now a future house when they see now a 3D model of a house. We suggest that under a special condition the answer should be positive: when the model significantly diminishes the risk of failure when we finally switch to acting in Plain

Reality. If, for example, the soundness of the model had been reliably tested before we turned to producing a real object or perform a real action.

MR visualizations do not bring knowledge-*that* of a new type unless they open for us the future in a new way, i.e., unless the visualized models are registered with reality. We stressed throughout the paper that the registration should take a variety of forms if the range of new knowledge is to qualitatively widen. At the same time, it remains unclear to us which forms of registration could be actualised and, importantly, whether it would make sense to actualise every one that could be.

Even once strong instrumentalism has been adopted, we may still find it difficult to decide the question. After all, does one have perceptual knowledge-*that* when they see pure MR presentation, presentation being no test of soundness? If MR presentations which tested nothing were not cases of perception, we would then have strange cases of handicapped visual experience which cannot turn into perception. Still, we mainly asked with what properties of models we should experiment to profit from artificial experiences and we suggested that experiences testing geometrical soundness are inferior in relation to the ones testing mechanical soundness.

We admit that our ultimate question was whether Augmented Reality allows us to experiment with our agentic soundness, i.e., to test the soundness of our manual skills. Here we did not move beyond speculations. On the one hand, it is obvious to us that reliable simulation is an extraordinary tool for making manual progress. And that it would be superb to have artificial experiences which could create the opportunity of reliable simulation. Given that, we find it quite stimulating to ask questions such as: Can we experiment with manual use of VR models placed in real surroundings, in an essentially similar way to the way we experiment with real objects placed in real surroundings, when we make plain experiments, or at least with real objects placed in unreal surroundings, as when we use standard simulators? It remains unclear to us whether MR technologies create such opportunities.

Although propagandists speak of unlimited capabilities of MR technologies, we find the issue of developing our manual skills within MR uncomfortable for them. If we lack reliable simulations of direct bodily contact with VR-objects, if we do not learn from simulations of touching them, if we do not make any simulated impact on them with our bare hands, then our knowledge-how cannot progress in a new way. Additionally, there are so many possible mutations of manual actions' simulations within MR that it becomes really difficult to decide which mutations are still challenging and which are already absurd. If, for example, a manual action involves an agent, some tools and some surroundings, in

some cases it is troublesome not only to decide what may be reliably simulated but also why it should be.

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